

CONFLICT IDENTIFICATION AND PRIORITIZATION IN PROPOSED TSANGYANG GYATSO BIOSPHERE RESERVE, EASTERN HIMALAYA, INDIA

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Along with the Greater Himalaya, in the eastern Himalayan region there has been increased efforts to bring more areas under the Protected Area Network. Protected areas including conservation areas in Arunachal Pradesh are mostly located in the low and mid-elevation forest areas. To address the need of having a protected area in the higher altitudes of the State, of late a biosphere reserve has been proposed in the western Arunachal Pradesh. This paper aims to document the existing human-wildlife conflict and prioritize the conflicts, in an effort to promote conservation in the Tsangyang Gyatso Biosphere Reserve. The paper also attempts to understand the complexity of land transfer and regulations of community, particularly pasture lands in the Biosphere reserve. This study was carried out between September 2007 and July 2008 in the proposed biosphere reserve. A total of 13 species were recorded to be in direct conflict with humans, and based on the conflict intensity mapping nine were screened as high to moderate conflicting species. Conflict intensity as per the local perceptions was recorded high for 38% species and 31% species showed moderate intensity of conflict with humans. As per the local perception, causes for human-wildlife conflict in order of importance were: increased population, non-timber forest products (NTFP) collection, road construction and increased predators. Local people perceived four major factors, namely compensatory schemes, reducing prey hunt, reducing pressure on forest and increasing vigil to safeguard crops and livestock to mitigate the existing conflicts.

INTRODUCTION

During the 5th World Park Congress organized by the IUCN, human-wildlife conflict (HWC) was identified to be a key challenge facing Protected Area management and conservation (IUCN 2003). A major source of conflict between park authorities and local communities in the Subcontinent revolves around livestock and crop damage within Protected Areas (PAs) of their buffer zone (Kharel 1997; Mishra 1997; Hussain 2003). Today, the PAs are a pervasive land use covering 14.36% of earth's surface (www.tradingeconomics.com/world/terrestrial-protected-areas-percent-of-total-surface-area-wb-data.html). There are indications that the PAs will continue to grow as individual countries have made ambitious commitments to establish new PAs; however the relative rate of growth of PAs is not significantly different between countries with different number of unprotected species (Pyke 2007). Most of the areas under PAs network, historically productive in terms of their economic value (Scott *et al.* 2001), have decentralised land management regimes and multifaceted land protection measures that hinder the optimal use of the land resource (Theobald and Hobbs 2002). Many international NGOs have strongly advocated the use of setting map-based geographical priorities while not affecting the established social and economic drivers in the region (Olson and Dinerstein 1998; Myers *et al.* 1999). In spite of all these efforts there seems to

be lack of political will to formulate a conservation policy, which is clearly evident from existing gaps between the conservation policies and conservation practice in general (Chhatre and Saberwal 2005). Prioritization of areas for biodiversity representation is essential for conservation planning, particularly in megadiverse countries where high deforestation threatens biodiversity (Sanchez-Cordero *et al.* 2005). In general, two methods of prioritization have been used, (i) sets of place based on expert advice (Dinerstein *et al.* 2000) and (ii) using algorithmic data containing the vital conservation information (Margules *et al.* 1998). We hereby discuss the former in the western part of Arunachal Pradesh, which forms a major part of the biological hotspot – Eastern Himalaya (Myers *et al.* 1999).

Approximately 10% of the world's population lives in mountain areas and livestock is the major source of their economy (Pun and Mares 2000; Mishra *et al.* 2006). India has a high human population and boasts of having the largest cattle population in the world (449 million; WRI 1996). Habitat loss in the Himalayan region is a serious concern as the region supports very fragile ecosystems. There have been attempts to link the fauna with its habitat or native flora globally (Siemann *et al.* 1998; Knops *et al.* 1999). It is estimated that the Himalayan region has lost 70% of its native habitat (Anonymous 2006). Therefore, in most of the Indian Himalayan region biodiversity conservation measures are usually taken care of by declaring PAs (Bagchi *et al.* 2004).

Loss of human life due to wildlife is often immediately discussed, but the loss of crops or livestock which are means to subsistence seldom get attention of administrators (Rao *et al.* 2002). More than often loss of subsistence causes much displeasure to locals in the conservation priority areas (Parry and Campbell 1992; Newmark *et al.* 1993; Maikhuri and Rao 1998). In Manas National Park human-elephant conflict is on the rise, the intensity of conflict was higher in fields and nearby parks; elephant bulls were reported to be more violent than the females (Nath *et al.* 2009). A seasonal study of the crop raiding patterns of elephant in Zimbabwe suggest that the point at which the quality of wild grasses declines to the quality of crop species correspond to the movement of bull elephant out of PAs and into fields (Osborn 2004). In Garo hills, India, the analysis of elephant movement using participatory monitoring suggested that elephant visits to fields peaked at the time of harvest of crop (Datta-Roy *et al.* 2009).

Crop raiding by primates are reported throughout the globe, especially in the tropical and subtropical regions. In Indonesia, *Macaca fascicularis* and *Presbytis thomasi* are most destructive primates in the region (Marchal and Hill 2009). Crop raiding by *Semnopithecus entellus* in and around Aravalli region of India is very high as these primate species can feed upon 184 types of food items and incur crop losses worth \$1,800-2,400 annually (Chhangani and Mohnot 2004). Squirrels like *Funambulus palmarum* in addition to their natural diet also take significant portion of cardamom in the Western Ghats of India (Chakravarthy *et al.* 2008).

Livestock depredation by wild animals is also the cause of resentment among traditional herders and pastoral people. Livestock depredation is increasingly becoming a contentious issue in the Himalayan region (Jackson and Wangchuk 2004). In Nepalese Himalaya, conflict with rural communities due to livestock predation by large carnivores like the Snow Leopard, Leopard, Wolf and Wild Dog has risen sharply in recent years (Jackson 1996). Therefore, the present paper attempts to understand the man-animal conflict and possible mitigatory measures to foster a pro-people biosphere reserve management.

The state of Arunachal Pradesh has been of great interest to biologists with recent discoveries of primate species — Arunachal Macaque *Macaca munzala* (Sinha *et al.* 2005), a new species to science, and range extension of the Tibetan Macaque *Macaca thibetana* (Kumar *et al.* 2005) in India; a new bird species to science — Bugun Liocichla *Liocichla bugunorum* has recently being described (Athreya 2006). Three other large mammals previously unknown from India: two species of deer – Leaf Deer *Muntiacus putaensis* (Datta *et al.* 2003), and the Black Barking Deer *Muntiacus crinifrons*

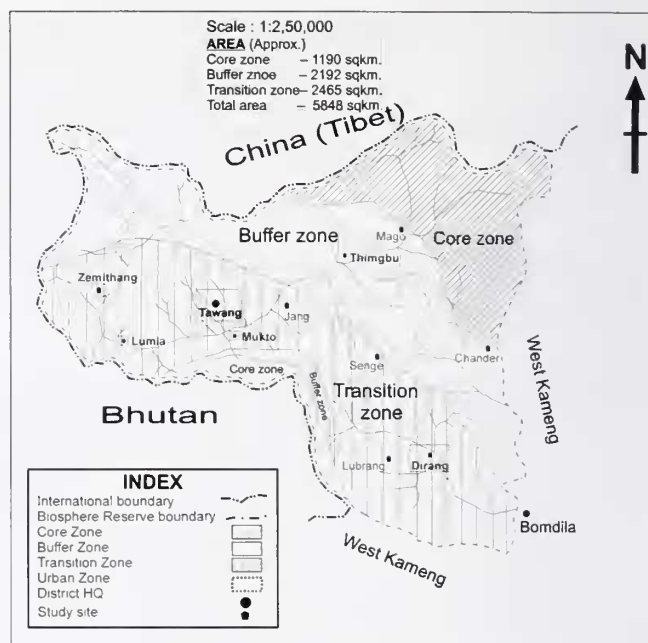


Fig. 1: The proposed Tsangyang Gyatso biosphere reserve showing study sites

– and the Chinese Goral *Nemorhaedus caudatus*, a primitive mountain goat (Mishra *et al.* 2006), have also been discovered in Arunachal Pradesh recently. There have been confirmed sightings of Black Musk Deer *Moschus fuscus* (Kumar and Nair 2007) and of fishes like *Amblyceps arunachalensis*, *Psilorhynchoides arunachalensis*, *Erethistoides senkliensis* (Nath and Dey 1989; Nebeshwar *et al.* 2007; Tamang *et al.* 2008) and probably many more that await description. To conserve this biodiversity, the state and the central government have initiated steps by bringing this area under the existing national/state PA network by proposing it for a biosphere reserve status. The region harbours significant altitudinal variation (100-7,090 m above msl), which creates myriads of habitat for different types of flora and fauna (Chaudhry *et al.* 2006). Arunachal Pradesh is located at the junction of Palearctic and Indo-Malayan realms, which enriches its biodiversity (Mani 1974). The state is known to have 50% angiosperms and avifauna of India (Rao and Hajra 1986; Singh 1994; Chowdhury 1998; Procter *et al.* 1998).

STUDY AREA

The survey was carried out in the Tsangyang Gyatso Biosphere Reserve (Fig. 1) in Western Arunachal Pradesh from September 2007 to July 2008. Tawang district spans over 2,172 sq. km with a human population density (16 per sq. km) marginally exceeding the average for Arunachal (13 per sq. km). The region is drained by the Tawang Chu, Nyamjang Chu (both of which meet and drain into Bhutan)

and their tributaries, and comprises five administrative circles (Tawang, Mukto, Thingbu, Lumla, and Zemithang). The Buddhist *Monpa* tribe is the predominant community inhabiting Tawang. There is a considerable presence of the Indian Army in the district, given that it shares international boundaries with Bhutan and China. The larger (7,422 sq. km) West Kameng district has a lower human density (10 per sq. km), with the people belonging to 5 tribes: *Monpa*, *Sherdukpen*, *Howa*, *Aka*, and *Miji*. The region is drained by the Kameng or Bhareli and its tributaries (eventually joining the Brahmaputra), and is divided into six administrative circles (Bomdila, Dirang, Kalaktang, Bhalukpong, Nafra, and Thrizino).

METHODOLOGY

The study was carried out in the Western Arunachal Pradesh in the districts of the West Kameng and Tawang, eastern range of the Himalaya. The study villages were selected based on reports of human-animal conflicts. An informal questionnaire was used to assess the response of the villagers (Table 1). A total of 149 individuals were interviewed comprising 109 males and 40 females. The secondary information regarding the study area was also collected from six villages. The targeted people belonged to different groups, such as the village headman, school teachers, servicemen, farmers and hunters.

Survey was conducted in the Chander, Lubrang and Senge villages under Dirang circle of West Kameng district and Jang, Mago of Thingbu circle and Zemithang of Zemithang circle, Tawang district. This study was carried out between September 2007 and July 2008 in the proposed biosphere reserve (BR). An informal discussion, with the help of visual identification aid, was used to enlist number of species in the proposed biosphere reserve, which were confirmed by either sighting them or by trophies in possession of villagers. The identification of mammals was

carried out with locals using the book *A FIELD GUIDE TO INDIAN MAMMALS* by Vivek Menon (2003) and photographic plates developed by us. IUCN Red Data book was referred to ascertain the threat status of the species enlisted in the survey.

RESULTS

Vegetation types

The vegetation type in the two study districts – West Kameng and Tawang – can be classified into the following five types (Dutta Choudhury 1996; Anonymous 2003) — Tropical evergreen, Subtropical evergreen, Temperate forest, Sub-alpine fir vegetation and Alpine vegetation (Table 2). The total forest cover of the two districts reports about 5,809.91 sq. km area, which accounts for 60.5% coverage as compared to the total area of both the districts, with 56.6% for Tawang district and 61.7 % in case of West Kameng district (Table 2) respectively. The tropical evergreen forests are found along the foothills of southern West Kameng district up to an altitudinal range of 900 m. Out of the two districts, tropical evergreen forests are found only in the West Kameng district covering an area of 494.5 sq. km. The subtropical evergreen forest or mixed forest covers an area of 1,714.85 sq. km of both the districts and are found at an altitudinal range of 900-1,800 m, largely in the Kalaktang and Rupa valley area of West Kameng district. The temperate forests are confined to elevation ranging from 1,800 to 3,500 m and are found mainly in Bomdila, Dirang (West Kameng district), Senge, Jang and Tawang valley (Tawang district) covering an area of 3,031.3 sq. km. The sub-alpine fir vegetation covers an area of 465.8 sq. km in both the districts and are found in Lower Sela area, hill slopes above Tawang valley, Mago area and Jung valley (of Tawang district) at an altitudinal range of 3,500 to 4,500 m. Alpine vegetation dominated by herbaceous species like *Rheum*, *Arenaria*, *Saussurea*, etc. along with *Rhododendron* spp. are

Table 1: Questionnaire used in the study of conflict mitigation

1. How many different species you see in your locality?
2. Could you identify them with these colour plates?
3. Do some of them raid your crops?
4. Do some of them predate on your livestock?
5. What time do they attack your crops/livestock (day/night)?
6. What is the extent of the damage (high/moderate/low)?
7. Do you kill them in grudge when they damage the crop (yes/no)?
8. What are the causes due to which their attacks have become frequent?
9. What do you think could be done to reduce the damage or stop killing wild animals?

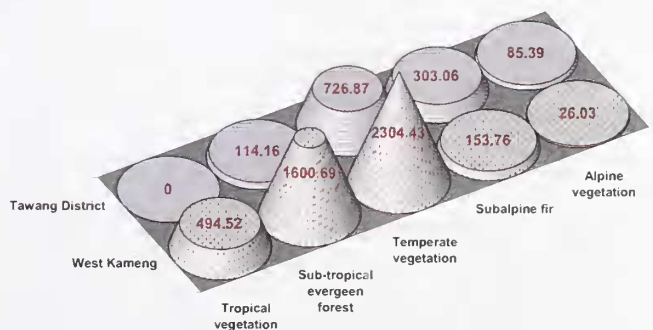


Fig. 2: Vegetation and forest types of the studied districts

found within an altitudinal range of 4,500 to 5,500 m. Covering an area of 111.4 sq. km in both the districts, alpine vegetations are found only in the hill slopes around Bumla, Pangchen, Chuna and Tawang (Tawang district). Fig. 2 shows the relative areas covered by these five types of vegetation.

Demographic profile

The total population of the Tawang district is 38,924 and that of West Kameng is 74,599. There are five major tribes in the West Kameng district while Tawang district has only one. *Aka*, *Miji* and *Bugim* are the three tribes, who are predominantly shifting cultivators, while *Sherdukpen* and *Monpas* are purely settled cultivators. The *Aka*, *Miji* and *Bugim* live at low elevations (200-2,200 m) in the tropical to subtropical zones, while the *Monpas* and *Sherdukpen* live in temperate to alpine zones. Agriculture, horticulture, NTFP collection and livestock rearing are the major source of income for the local people. *Monpas* living in the higher reaches, beyond 3,000 m, practice transhumance type of pastoralism with barter links, with the people at the lower elevation (Chaudhry *et al.* 2006; Dollo *et al.* 2006). In recent times, there has been increased thrust for developmental activities like installment of brewery, pine extraction unit and hydel projects at the lower reaches, while at the higher elevations road construction, army settlements, pasture expansion are cause of habitat destruction (pers. obs.).

Altogether 6 villages were selected for the study in the 2 districts of the state. Senge was the largest having 152 houses followed by Jang 119, while the lowest was Chander having only 20 houses. Similar trends were recorded in terms of population with Senge having 35%, Jang 27.4%, Zemithang 14.5%, Mago 13.1%, Lubrang 5.3% and Chander 4.6%. Mago and Chander were pure pastoral villages. Jang had maximum of the agricultural workforce 58%, Senge 37.9%, Zemithang 3.7% and Lubrang had the lowest with 0.4%. Most of the people

worked in the primary sector (mainly labour work). Senge had the largest chunk with 73% of workers followed by Jang 13.6%, Zemithang 3.8%, Mago 6.8%, Lubrang 0.6% and Chander 2.1%. Non-workers chiefly comprising of kids and elderly also accounted for a significant number, while workers are those who had worked for the major part of the reference period (i.e., 6 months or more). Average land holding was found at the higher elevation villages, which may be attributed to lack of infrastructure like road, the trends reversed in areas having road connectivity like Zemithang, Senge and Jang (Table 3).

Six villages were identified in the reconnaissance survey as the flashpoints of man-animal conflict. These villages broadly fall in three ecological zones, i.e., subtropical, temperate, sub-alpine and alpine zones covering two districts of the state. Vegetation is subtropical broad-leaved forest in Zemithang, broad-leaved temperate forest in Chander, sub-alpine coniferous forest in Senge and alpine pasture in Mago. In Jang, the vegetation is temperate broad-leaved mixed forest while Lubrang is a pastoral village with grasses like *Poa alpina*, *Juncus thomsonii* etc and surrounded by temperate broad-leaved forest. A total of 12 animal species, including domestic dog, were identified to be in direct conflict with human interests in these sites, which can be conveniently divided into two categories: livestock depredators and crop raiders. Jang, Zemithang and Chander had 3 conflicting species followed by 2 each in the remaining villages (Table 4).

Faunal diversity

According to our initial study and literature review there are 40 species of mammals belonging to 34 genera in the proposed biosphere reserve; altogether 18 families belonging to 8 orders. 22 (55%) species of the animals were recorded in the low risk category (LR), 5 (12.5%) species were recorded in the endangered list (EN), 7 (17.5%) were found to be in

Table 2: Vegetation types with dominant species in the study area (in sq. km)

Vegetation Type	Tawang (area in sq. km.)	West Kameng (area in sq. km.)	Dominant species
Alpine vegetation	85.39	26.03	<i>Rheum australe</i> , <i>Berginia purpurascens</i> , <i>Rhododendron lepidotum</i> etc.
Sub-alpine fir	303.06	153.76	<i>Abies densa</i> , <i>Rhododendron barbatum</i> , <i>Berberis aristata</i> , <i>Anemone rivularis</i> etc.
Temperate vegetation	726.87	2,304.43	<i>Rhododendron arboreum</i> , <i>Magnolia campbelli</i> , <i>Quercus griffithii</i> , <i>Pinus wallichiana</i> etc.
Subtropical evergreen forest	114.16	1,600.69	<i>Ficus palmata</i> , <i>Castanopsis tribuloides</i> , <i>Callicarpa arborea</i> , etc.
Tropical vegetation	0	494.52	<i>Altingia excelsa</i> , <i>Ailanthus grandis</i> , <i>Sterculia villosa</i> , <i>Duabanga grandiflora</i> etc.
Total Forest Cover	1,229.48 (56.6%)	4,579.43 (61.7%)	

the vulnerable list (VU), 3 (7.5%) in the least concerned (LC), 1(2.5%) species was near threatened, 2 (5%) species were, however, not found in the IUCN listings. As far as mammalian families are concerned, there were 18 families, Bovidae and Felidae were the largest comprising 15% representation each, followed by Scuridae having 12.5%, Cercopithecidae and Mustelidae 10% each, Muridae and Cervidae had 5% each, while rest of the families had 5% each of the species representation. Carnivora 35% was largest order, followed by Atriodycta 25%, Rodentia 20%, Primate 12.5%, Lagomorpha, Perissodactyla and Pholidata contributed 2.5% each. Hence, from the enumeration it can be concluded that carnivore diversity was maximum followed by herbivore, and therefore livestock depredation would be a concern in the immediate future. As per the villagers, the numbers of Tiger *Panthera tigris* and Kiang *Equus kiang* are very low and often their sightings are seasonal.

Conflicting species

There were altogether 13 animal species which were in direct conflict with humans. Out of which two Greater Bandicoot Rat *Bandicota indica* and Domestic Dog *Canis familiaris* live in close association with humans, while the other 11 species were found in the wild. Crop raiders and livestock depredators had equal share of representation, i.e., 54%. Himalayan Black Bear *Ursus thibetanus* had the unique distinction of having the ability to raid crops and kill livestock. Conflict intensity as per the local perception was recorded high for 38% species, while 31% species show moderate intensity of conflict with humans and therefore need proper attention before they become a threat. Rest 31% showed low intensity of conflict, which may be partly attributed to their behavioural patterns and partly due to availability of alternate feeding materials. Snow Leopard *Uncia uncia*, Wild Dog *Cuon alpinus* were blamed for

maximum livestock depredation and were subject to retaliatory persecution. However, according to the villagers, their sightings have gradually diminished in recent times. Wild Boar *Sus scrofa* and Arunachal Macaque *Macaca munzala* have been cause of grave concern for their crop raiding behaviour (Table 5).

Based on the conflict intensity mapping, nine potential species were screened as high to moderate conflicting species out of total thirteen. Omnivores lead the tally with 44% representation, primates (33%) constituted the herbivore group, while carnivores had 22% representation. 56% showed diurnal activity while remaining 44% were nocturnal. All the herbivores had affinity towards feeding young leaves while Malayan Porcupine *Hystrix brachyura subcristata* was reported to be feeding more on bulbs and tubers, it may be noted that the species is also known to cause debarking of trees and their subsequent death. Domestic Dog *Canis familiaris* is a known human ally since time immemorial and only recently it has been on the list due to its predating activity, especially on young calves. The other omnivores were found to be feeding much on the fruits, grains, berries and on small mammals. Pure carnivores like Snow Leopard *Uncia uncia* and Wild Dog *Cuon alpinus*, however, were dependent on goral, deer and small animals (Table 5).

Factors inducing conflicts and prioritization of conflicts

Five causes for conflict, namely deforestation, road construction, NTFP collection, increased number of livestock predators and increased population for man-animal conflict were identified, in all the six study sites. According to the villagers, deforestation was reported to be the major cause of human-animal conflict, causing 18% of the incidents. The village-wise break-up of the deforestation as a cause of conflict was highest in Senge 29%, Chander 22%, Lubrang 18%, Mago, Jang 11% and least in Zemithang 7%.

Table 3: Occupational structure and demographic profile of study sites

Village	No. of Houses (No.)	Total Population (No.)	Agriculture and plantation (No.)	Main Workers (No.)	Livestock and forestry sector (No.)	Other services (No.)	Average house holding (No.)
Mago	57	301	0	126	53	34	5
Jang	119	486	158	252	0	3	4
Zemithang	63	231	10	71	0	84	4
Senge	152	1,795	103	1,353	95	1,231	12
Lubrang	23	162	1	12	0	35	7
Chander	20	87	0	39	26	35	4
Total	434	3,062	272	1,853	174	1,422	6

(Source: Census 2001, Govt. of India)

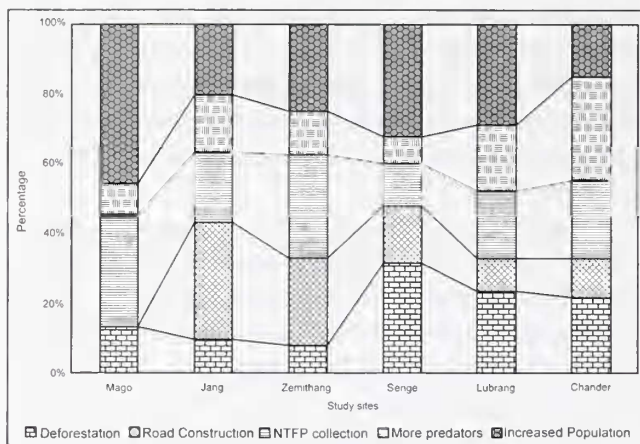


Fig. 3: Percentage of people (Y-axis) in study area (X-axis) citing cause of conflict

17% of the people in the study area thought that road construction has led to increased conflict. The break-up showed that Jang 40% had highest incidence of man-animal conflict following road construction followed by Zemithang 24%, Senge 16%, Chander 12% and Lubrang 8%. 22% of the people had identified indiscriminate NTFP collection as a cause of this conflict; the village wise break-up showed that Mago and Zemithang 21%, Jang and Chander 18%, Lubrang 12% and last Senge 9% shared similar views on NTFP collection as a cause of conflict. On an average, 16% of the people believed that conflicts are more prevalent nowadays due to increase in the number of crop raiders and livestock depredators, which according to them is true in case of Primates and Dholes. Village-wise break-up of increased

predators as a cause of conflict shows that 33% of people from Chander, 21% Jang, 17% Lubrang, 12% Zemithang and 8% each, Mago and Senge supported this view. The major cause according to the respondents was increased population (27%). Mago had highest number of people having this view (25%) followed by 20% in Senge (which has an army built up in the area), Jang, Zemithang and Lubrang 15% each and lastly Chander (10%) (Fig. 3).

Therefore, according to people's perception causes for human-wildlife conflict in order of importance were increased population > NTFP collection > road construction > increased predators. All these factors are related to each other as well as with economics. Subsequent ban on timber logging by Supreme Court in 1996 has resulted in greater reliance on NTFPs, and livestock and animal husbandry. Road construction and development impetus in the area increased after the 1962 Sino-Indian Conflict, resulting in habitat loss of wild animals. These factors have resulted in increased man-animal conflict. The analysis was further extended to identify adequate measures to reduce the man-animal conflict in the biosphere reserve. Four factors were enlisted by the local people as compensatory schemes, reducing prey hunt, reducing pressure on forest and increasing vigil to safeguard crops and livestock. Compensatory schemes were demanded by the local people and this constituted an overall of 32% demand in the region. Chander had highest 20%, Mago and Zemithang 19% each, Jang 17%, Senge 15% and Lubrang 10%. Most of the compensation demanding villages are pastoral village and have limited access to roads. The

Table 4: Study areas under maximum incidences of human-wildlife conflict

Study villages	Geographical Gradient & Elevation (m above msl)	Dominant vegetation	Conflicting species
Mago	27°41' 11.4" N, 92°12' 10.6" E 3,600 m	<i>Poa alpine</i> , <i>Aletris pauciflora</i> , <i>Juncus thomsonii</i>	Snow Leopard <i>Uncia uncia</i> , Wild Dog <i>Cuon alpinus</i>
Jang	27° 34' 54.1" N, 91° 58' 54.2" E 2,400 m	<i>Quercus grifithii</i> , <i>Lyonia ovalifolia</i> , <i>Pinus wallichiana</i>	Domestic Dog <i>Canis familiaris</i> , Arunachal Macaque <i>Macaca munzala</i> , Rhesus Macaque <i>Macaca mulatta</i>
Zemithang	27° 42' 40.4" N, 91° 43' 49.7" E 2,300 m	<i>Quercus grifithii</i> , <i>Rhododendron arboreum</i>	Arunachal Macaque <i>Macaca munzala</i> , Malayan Porcupine <i>Hystrix brachyura</i> <i>subcristata</i> Wild Boar <i>Sus scrofa</i>
Senge	2,900 m	<i>Rhododendron grande</i> , <i>Tsuga dumosa</i> , <i>Arundinaria maling</i>	Domestic Dog <i>Canis familiaris</i> , Rhesus Macaque <i>Macaca mulatta</i>
Lubrang	27° 21' 57" N, 92° 10' 44.3" E 2,800 m	<i>Rhododendron arboreum</i> , <i>Acer pectinatum</i> , <i>Lyonia ovalifolia</i>	Wild Dog <i>Cuon alpinus</i> , Yellow-throated Marten <i>Martes flavigula</i>
Chander	27° 23' 5.5" N, 92° 20' 30.4" E 2,950 m	<i>Betula alnoides</i> , <i>Acer oblongum</i> , <i>Rhododendron grande</i>	Wild Dog <i>Cuon alpinus</i> , Yellow-throated Marten <i>Martes lavigula</i> , Himalayan Black Bear <i>Ursus thibetanus</i>

other three villages that have road connectivity had less demand for compensation (10-17%). Reducing the hunting of prey such as deer, small mammals and birds to balance the prey-predator relation was agreed upon by 20% people. Jang and Zemithang had 20% each followed by Chander and Zemithang 17% each and lastly by remaining two villages 13% each. 27.5% people agreed to increase the vigil to reduce the crop and livestock loss to the wild animals, Jang had the highest with 24%, Lubrang 19%, Senge 17%, 15% each from Mago and Chander, followed by 10% of people in Zemithang. Similar views were shared about reducing pressure on the forest with 20% people from Chander, Lubrang, Senge and Jang, 17% people in Zemithang, 13% in Lubrang and least with Mago 10% (Table 6).

DISCUSSION AND CONCLUSION

It seems from the foregoing result that human-animal conflict in the proposed biosphere reserve is a serious issue. In the state, most of the studies related to mammals were restricted to taxonomical descriptions, but as a matter of fact their role in human-animal conflict has not been taken up adequately (Mishra *et al.* 2006). This arises primarily due to two counts, one there is lack of acclimatization with the people and second, the people distrust government agents either for

taxes or for land acquisition. Apart from these two, the recent religious ban on the hunting of animals inside forest by the Tawang monastery can also be accounted for the reluctance of the people to respond (pers. comm.). There are three direct stakeholders in the state department, i.e., agriculture, horticulture and forest departments, but none are keeping data on human-animal conflicts (pers. obs.). Most of the land is under forest cover and hence it is the dominant land use and in recent times it has been put to pressure owing to developmental activities (Dollo *et al.* 2006). The region has most of the forest under the category of unclassed state forest which are strictly under community control, and therefore they are governed by the customary laws of the community (Singh and Sundriyal 2006).

Community lands governed by traditional institutions are broadly divided into two groups – land tenureship and ownership. However, in recent times the traditional systems are under transition and are gradually taken up by the Panchayati Raj Institutions (PRI) having village headman (Gaonburha) who may have greater political mileage along with a handful of his subordinates which at times creates inequitable pattern of resource utilization affecting sustainability in long run (Chaudhry *et al.* 2006). As evident from Table 6 four factors are driving the man-animal conflict in the region (i) population (ii) loss of vegetation (iii) NTFP

Table 5: List of the animal species reported to have conflicts with humans

Species	Conflict			
	Livestock depredation	Activity time	Crop raiding	Conflict intensity
Rhesus Macaque <i>Macaca mulatta</i>	-	Diurnal	√	++
Capped Langur				
<i>Trachypithecus pileatus</i>	-	Diurnal, Crepuscular	√	+
Marbled Cat <i>Felis marmota</i>	√	Nocturnal	-	+
Snow Leopard <i>Uncia uncia</i>	√	Diurnal, Crepuscular	-	+++
Wild Dog <i>Cuon alpinus</i>	√	Diurnal, Nocturnal (Hunting)	-	+++
Malayan Porcupine				
<i>Hystrix brachyura subcristata</i>	-	Nocturnal	√	+++
Greater Bandicoot Rat				
<i>Bandicota indica</i>	-	Nocturnal	√	+
Arunachal Macaque				
<i>Macaca munzala</i>	-	Diurnal	√	+++
Wild Boar <i>Sus scrofa</i>	-	Nocturnal	√	+++
Yellow-throated Marten				
<i>Martes flavigula</i>	√	Diurnal, Nocturnal	-	++
Leopard <i>Panthera pardus</i>	√	Nocturnal	-	+
Domestic Dog <i>Canis familiaris</i>	√	Diurnal	-	++
Himalayan Black Bear <i>Ursus thibetanus</i>	√	Diurnal, Nocturnal	√	++

Key: - = absence of conflict; √ = presence of conflict; + = low conflict intensity; ++ = Moderate conflict intensity; +++ = High conflict intensity

Table 6: Remedial conservation measures as suggested by the villagers for reducing the conflicts

Villages	Compensation	No hunting of prey	Increasing vigil	Reducing pressure on forest
Mago (n=22)	9	4	6	3
Jang (n=30)	8	6	10	6
Zemithang (n=24)	9	6	4	5
Senge (n=25)	7	5	7	6
Lubrang (n=21)	5	4	8	4
Chander (n=27)	10	5	6	6

Figures in parenthesis indicate number of persons interviewed

collection and (iv) less vigil, all these factors are related to one another when the main need becomes quick money (Saha *et al.* 2006).

The government lacks data and outreach to the far flung areas and therefore there is lack of support for the rural and pastoral highlanders. Our data show that the respondents support compensatory schemes for crops or livestock lost to wildlife (Table 4). Most of forest related operations (timber, fuel, NTFPs, hunting) with the rising population were responsible for rise in the recent conflicts (Fig. 2). This is especially true when developmental thrust received a shot in arm after 1962 Sino-Indian conflict (Saha *et al.* 2006). There were number of roads constructed and rapid expansion of army settlements and urbanization process. Other developmental activities like horticulture areas expansion, pasture expansion have already aggravated forest status and hence the present day man-animal conflict has raised to alarming proportions. Therefore, the need of the hour is to document the best practices in the traditional institutions for

resource utilization, management and conservation, the region is known for its Buddhism related values and traditional modes of conflict resolution and compensation hold good for the future. An ideal situation will be to complement the traditional knowledge with that of formal conservation science.

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